Bay Area Air Quality Management District
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Draft Staff Report

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Proposed BAAQMD
Regulation 8, Rule 53:
Yeast Manufacturing

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REGULATION 8, RULE 53
YEAST MANUFACTURING

INTRODUCTION

The proposed Rule requires controls of emissions from yeast manufacturing operations. Yeast manufacturing emissions include ethanol (a precursor organic compound {POC}), acetaldehyde (a toxic air contaminant, as well as a POC), and other compounds. Uncontrolled emissions are odorous, and can cause detectable off-property odors at levels that result in complaints and public nuisance, under some conditions.

There is one yeast manufacturing facility in the Bay Area: Lesaffre Yeast Corporation, which has been operating in West Oakland for over 100 years. The proposed rule will reduce POC emissions from Lesaffre between 5 to 12 tons per year, depending upon the compliance strategy selected by Lesaffre. It will greatly reduce the impact of odors on the community, making odors from the facility's stacks undetectable except for extremely unusual conditions.
Yeast plants are currently subject to Regulation 8, Rule 2 (Miscellaneous Operations). District source tests have shown that Lesaffre can comply with Regulation 8-2 except when producing stock batches. Lesaffre is currently shielded from enforcement of this regulation, however, by its current Title V permit. When the Title V permit was issued in 1997, the District determined that Lesaffre (then Red Star Yeast) qualified for the exemption contained in Regulation 8-2-111 (preparation of foods). The District has since revised that determination, and the shield will be removed when the existing Title V permit is no longer in force. This will occur when the District takes final action on Lesaffre's application for renewal of its Title V permit.

Adoption of proposed Regulation 8-53 will mean that Regulation 8-2 no longer applies.

BACKGROUND

There are currently 12 manufacturing plants in the United States, owned by six major companies. Of these 12 plants, two are located in California. American Yeast Corporation operates one plant in Bakersfield. Lesaffre Yeast Corporation owns the plant located at 1384 N. 5th Street, Oakland. This existing yeast manufacturing plant is currently the source of emissions of odorous compounds that are occasionally noticeable to nearby residents. The District receives an average of two to three complaints per week that identify Lesaffre as a source of offensive odor. Three incidents in the past year have resulted in enough complaints to result in a Notice of Violation for public nuisance.

Yeast is manufactured by a natural, organic process of fermentation. The raw material for the fermentation is molasses. A batch is made by filling a large fermentation vessel with water, inoculating the water with seed yeast, then feeding the fermenting liquid with molasses, nutrients, and air over a period of about 15 hours. When a batch is finished, the yeast is filtered from the batch and sold in a semi-solid or liquid state.

The air that provides oxygen carries away some of the byproducts of fermentation, most notably ethanol and acetaldehyde. The concentrations of these compounds are high enough to be odorous at the stack. Under some weather conditions, the odors can be detectable (occasionally at annoying levels) at ground level.

There are three types of batches: trade, first generation, and stock. The stock batch is a small batch in which the seed yeast for the other batches is made. Trade batches are batches in which the commercial yeast product is made.

In 2000, EPA adopted a Maximum Achievable Control Technology (MACT) rule for Yeast Manufacturing. 40 CFR 63, Subpart CCCC. This rule set standards for each type of batch. The MACT standard was based upon emissions achieved by existing facilities using process controls. It is effective May 1, 2004.

The Department of Environment of Maryland and the Department of Natural Resources of Wisconsin have developed regulations to control organic compound emissions from yeast manufacturing. Emission limitations range from 300 ppm to 900 ppm of total VOC (expressed as methane) for trade, first and stock generation batches, which are equivalent to the limits specified in the NESHAPS. These limits can be achieved by implementing a continuous monitoring system and optimized the sugar feed rate to maximize yeast yield and suppress ethanol and acetaldehyde formation.

BAAQMD source tests have shown that Lesaffre Yeast meets these levels at this time because the plant is equipped with continuous monitoring systems.

A new trade fermenter at the Bakersfield plant was installed in 1998. San Joaquin Air Quality District determined that Best Available Control Technology (BACT) for the fermenter was an emission rate of 1.25 pounds VOC/ton yeast products. This level was also achieved by implementation of process controls.

Yeast plants are currently subject to Regulation 8, Rule 2 (Miscellaneous Operations). District source tests have shown that Lesaffre can comply with Regulation 8-2 except when producing stock batches. Lesaffre is currently shielded from enforcement of this regulation, however, by its current Title V permit. When the Title V permit was issued in 1997, the District determined that Lesaffre (then Red Star Yeast) qualified for the exemption contained in

Regulation 8-2-111 (preparation of foods). The District has since revised that determination, and the shield will be removed when the existing Title V permit is no longer in force. This will occur when the District takes final action on Lesaffre's application for renewal of its Title V permit.

Compliance with Regulation 8-2 will not eliminate the odors in the community. The District has reviewed the patterns of odor complaints and compared them with Lesaffre's operating records. The District found no correlation between complaints and the higher emissions that occur during stock and first generation batches.

Dispersion modeling conducted by District staff indicate that emissions overall will have to be reduced in order to address the odor problem.

Reduction of precursor organic compounds from Lesaffre will also assist the District's ozone attainment effort. Considering only the reductions in POC, however, the proposed Rule's cost effectiveness is $[ ]/per ton, which is above the levels generally recommended for ozone control measures. Staffs recommend approval of a more costly standard, however, in order to address the persistent odor problem.

While acetaldehyde is a toxic air contaminant, District staff have determined that Lesaffre's impact on public health is insignificant. While the proposed control measure will reduce emissions of toxic air contaminants, the direct health benefit is not an important factor in the staff recommendation.

The proposed Regulation 8, Rule 53 - Yeast Manufacturing contains the following requirements.

- Effective February 1, 2004, fermenters shall not discharge into the atmosphere any emission containing a concentration of more than 75 PPM total carbon organic on a dry basis. This will reduce emissions by approximately 90% from the highest level.

PROCESS DESCRIPTION

Nutritional yeast is produced by aerobic fermentation of a selected culture of *Saccharomyces cerevisiae*. Lesaffre receives the molasses and the cultures by tanker trucks and test tubes, respectively. The molasses is diluted, pH adjusted, clarified and flash cooked to produce a sterile molasses media. The molasses media is then stored in a sterile mash tank until injection into a fermenter.

Fermentation process starts by growing yeast cells in a series of fermentation vessels. Fermentable sugars (molasses) and other raw materials such as nitrogen, potassium, phosphate, magnesium, calcium and small amounts of vitamins are added to the fermenters, allowing the yeast to grow under aerobic conditions (excess air) and at an ideal, akaline pH growth condition. Each fermentation cycle ranges from 7 to 24 hours. Typically, three stages of fermentation are performed: stock, first generation and trade stages. In each stage, the mass of yeast increases.

The yeast is harvested at the last fermentation cycle (trade) by a series of centrifuges, washed with water, and re-separated to a cream of 17-20 % solids. The cream is stored in a refrigerated vessel, and is shipped via tanker truck to customers or is pumped to the packaging section. At the packaging section, the cream is further filtered by a rotary vacuum filters to concentrate the yeast up to 32% solids, then extruded, cut and packaged.

Fermenters are normally equipped with an incremental feed system so the pH, and byproducts can be controlled. The process control system will continually monitor the VOC concentration in the vapors leaving the fermenters. A Flame Ionization Detector (FID), connected to the control system, will be utilized to measure the VOC concentration at the fermenter's outlets. The control system will automatically adjust the volume of molasses in the feed to minimize VOC emissions, while maintaining the optimum growth condition.

EMISSIONS SUBJECT TO CONTROL

Volatile organic compound (VOC) emissions are generated as byproducts of the yeast fermentation process. The yeast consumes sugars and generates acetaldehyde and carbon dioxide, which in turn form ethanol. Other byproducts consist of insignificant amounts of other alcohols, such as butanol, isopropyl alcohol, 2,3-butanediol, organic acids, and acetates. Approximately 79 to 90 percent of the emissions generated are ethanol and the remaining 10 to 21 percent consists of mostly acetaldehyde and small amounts of other alcohols.

The rate of ethanol formation is higher in the earlier stages than in the final stages of the fermentation process. However, there are only about 26 stock batches (first stage) compare to 106 first generation batches (second stage), and 1008 trade batches (last stage) per year.

Table 1 shows the estimated emissions for the five fermenters at Lesaffre Yeast after numerous operational improvements to the yeast manufacturing process.

Table 1

Fermenter Totals (Predicted using June and July 2002 data - extrapolated for an entire year)

Ferm. No.	No. Batches	VOC (TPY)	Acetaldehyde (TPY)	Ethanol (TPY)	Fermenter Hrs of Operation
1	263	4.7	1.0	3.7	3,945
2	199	4.8	1.0	3.8	2,937
3	193	2.9	0.6	2.3	2,895
4	219	3.4	0.7	2.7	3,285
5	266	4.5	0.9	3.5	3,940
Total Sum	**1140**	**20.3**	**4.2**	**16.1**	**17,002**

Table 2 shows the estimated emissions for five fermenters at Lesaffre Yeast after implementation of the new Regulation 8, Rule 53, assuming 90% VOC reduction for 26 stock batches per year from fermenter no. 2, and average 50% VOC reduction for trade and first generation batches from other fermenters.

Table 2

Fermenter Totals (Estimated after an add-on control system)

Ferm. No.	No. Batches	VOC (TPY)	Acetaldehyde (TPY)	Ethanol (TPY)	Operation Hrs
1	263	2.35	0.50	1.85	3,945
2	199	0.84	0.18	0.66	2,937
3	193	1.45	0.30	1.15	2,895
4	219	1.70	0.35	1.35	3,285
5	266	2.25	0.45	1.80	3,940
Total Sum	**1140**	**8.6**	**1.8**	**6.8**	**17,002**

HAZARDOUS AIR POLLUTANTS

EPA has identified the nutritional yeast manufacturing source category as a major source of hazardous air pollutants (HAP) emissions of adetaldehyde. Section 112(d) of the Clean Air Act (CAA) requires all major sources to meet HAP emission standards reflecting the application of the maximum achievable control technology (MACT). Effective May 21, 2001, all nutritional yeast manufacturers that are classified as major sources (i.e. emit 10 tons a year or more of a single HAP or 25 tons per year or more of a mixture of HAPS) are subject to the standards specified in Title 40 of the Code of Federal Regulations (CFR), Parts 63, Subpart CCCC. For existing sources, the effective date is May 21, 2004. Subpart CCCC required at least 98% of all batches in each 12-month calculation must not exceed 300 parts per million by volume (ppmv) for trade (last stage), 600 ppmv for first generation (second stage) and 900 ppmv for stock (first stage) measured as methane, and averaged over the duration of a batch. At this time, Lesaffre is the only facility in the Bay Area that is potentially subject to the NESHAP. Lesaffre already meets National Emission Standard for Hazardous Air Pollutants (NESHAP) limitations by implementing a continuous monitoring system, and optimizing the sugar feed rate to maximize yeast yield and suppress ethanol and acetaldehyde formation.

At present, it is unclear whether Lesaffre will be subject to the NESHAP. This is because recent process improvements at the facility may have reduced emissions below NESHAP applicability thresholds.

On May 7, 2002, the District completed a health risk screening analysis for acetaldehyde emissions from five fermentation vessels from Lesaffre. The maximum health risks were estimated using guideline procedures adopted for use in the Air Toxics Hot Spots (ATHS) Program. For acetaldehyde, the Office of Environmental Health Hazard Assessment (OEHHA) has adopted a chronic inhalation Reference Exposure Level (REL) of 90 micro grams per cubic meter ($\mu g/m^3$), and an inhalation cancer unit risk factor (URF) of 2.7E-6 $(\mu g/m^3)^{-1}$. The risk screen estimated a maximum lifetime cancer risk of 7.8E-6 (7.8 in one million). The maximum chronic hazard index was estimated to be 0.46. These results were based on the year 2000 data (16.25 ton per year of acetaldehyde). The actual emissions recorded in 2001 (4.2 ton per year of acetaldehyde) are much lower because of the operational improvements that were phased in and fine tuned starting in the spring of 2001 (when Lesaffre took over the ownership of the plant). These health impacts are considered to be insignificant. See attached Appendix for the analysis.

ODOROUS COMPOUNDS

Lesaffre is still experiencing odor problems even though it has met the NESHAP requirements. Lesaffre can also causes odor complaints while complying with BAAQMD Regulation 8-2. The new Regulation 8, Rule 53 is more stringent than both the NESHAP and Regulation 8-2.

The odorous compounds from Lesaffre are yeast, molasses and acetaldehyde. Yeast has acidic odor similar to buttermilk. Yeast is used to ferment carbohydrates and is a microscopic, one-celled fungi. Molasses is a dark brown viscous liquid and is a by-product of sugar processing. It is sweet, and has a sugary odor. The odor is strongest when being cooked. At high concentration, acetaldehyde has a pungent suffocating odor, but at dilute concentrations, it has a fruity odor. Acetaldehyde is a by-product of yeast fermentation, and when combined with carbon dioxide, it forms ethanol.

District staff conducted odor modeling using the EPA's ISCST3 dispersion model to determine whether emissions from the facility would likely result in short-term ambient air concentrations that exceed the published odor detection threshold for acetaldehyde. An odor threshold of 90 $\mu g/m^3$ was used, as reported by EPA (http://www.epa.gov/ttn/atw/hlthef/acetalde.html). It should be noted that some individuals might still be able to detect the odor of acetaldehyde below this level. District staff considers this target level to be appropriate for several reasons. First, an odor may be *detected* but not be strong enough to be *annoying.* Second, the District's authority to control odors is to prevent public nuisances, defined in California Health and Safety Code §41700 as to affect "a considerable number of persons." Thus, a target level which is not detectable to most persons, and which will be perceived as mild to more sensitive individuals, is the appropriate target.

In order to keep the maximum ground level 1-hour-average or 3 minute average acetaldehyde concentration below the odor threshold 90 $\mu g/m^3$, Lesaffre would need to reduce the VOC concentration in its exhaust stacks to 75 ppm total carbon. To keep the peak 3-minute ground level concentration below the odor threshold, Lesaffre will also need to raise the emission stack height to 30 feet above the building roof because the existing stacks are heavily influenced by building downwash.

The proposed Regulation 8, Rule 53 limits VOC emissions to 75 ppm total carbon (averaged over one clock hour). A one-hour average was selected (instead of a shorter time period) for several reasons:

- The stack concentration varies over time, climbing steeply early in the batch, then falling off slowly after the maximum is reached. A one-hour average allows the operator to adjust unusually high concentrations without upsetting the process (which could lead to worse odors).
- The target stack concentration will result in perceptible, but not annoying, concentrations for a short period of time under unusual weather conditions. The rule should thus make detection of odors at any given point rare. Typical variations in wind speed and direction should make odors at any given point fleeting.
- Expressing the limit as an average over the batch is not appropriate because one of the objectives of this Rule is to eliminate odor problems. Therefore the Rule focuses on the highest, rather than average, concentrations.

The proposed Regulation 8, Rule 53 also includes good housekeeping measures for equipment maintenance and operating practices. All equipment associated with delivery and loading operations shall be maintained in good working order. Yeast products shall not be spilled, or handled in such a way that would result in evaporation to the atmosphere. Two of the notices of violation issued to Lesaffre last year were for odors caused during handling of molasses. A third public nuisance incident just occurred, caused by odors from the stack.

As mentioned earlier, San Joaquin Air Quality District determined that Best Available Control Technology (BACT) for the trade fermenter was 1.25 pounds VOC/ton yeast products. This level was achieved by implementation of process controls without installation of an add-on abatement device. Lesaffre already meets this level for both First Generation and Trade batches. The proposed limit of 75 ppm is significantly more stringent than the 1.25 lb/ton BACT level.

CONTROL STRATEGIES

The current emissions and the control required by this Rule are shown in Table 3. The hourly maximum concentrations were taken from data provided by Lesaffre during the month of August in 2002.

Table 3

Control efficiencies required by proposed rule

Batch Type	Hourly maximum (ppm as C1)		
	Current	Limit	% redxn
Stock	750	75	90
1st Gen	340	75	78
Trade	270	75	72

The operator may achieve the required control by any combination of process modification and abatement technology. Process modifications are preferred because:

- Pollution prevention is preferred where feasible.
- Process modifications are usually much less expensive than abatement technologies.
- Process modifications can reduce the cost of any required additional abatement technologies by reducing the volume of air that requires treatment.

The initial abatement technologies considered were the following:

- Adsorption
- Concentration
- Condensation
- Absorption
- Thermal Oxidation
- Catalytic Oxidation
- Biofiltration

Adsorption: EPA document EPA-450/3-91-027 " Assessment of VOC Emissions and Their Control from Baker's Yeast Manufacturing Facilities" dated January 1992 indicates that the carbon adsorption in not feasible due to the low VOC concentration of the exhaust stream (< 500 ppmv). In addition, acetaldehyde in the exhaust stream would react with, and destroy, the carbon. Therefore, carbon adsorption is not a technologically feasible control option. Zeolite adsorption materials are not effective at removing alcohols. Therefore, zeolite adsorption is not a technologically feasible control option.

Concentration: combines adsorption and oxidation technologies. A low-concentration stream is passed through an adsorption device, and the contaminants are desorbed (using hot air) at a higher concentration. The hot air is then sent to an oxidizer, which is smaller and cheaper to build and operate because of the higher concentration. Because adsorption is not feasible, concentration is not feasible either.

Condensation: is another control technology that is not feasible for yeast manufacturing. Typically condensation works best with concentration greater than 5000 ppm and with VOC's boiling points greater than 104°F (40°C) and high molecular weight. Acetaldehyde in the fermenter's exhaust stream has a boiling point well below 104 °F, and the concentration is less than 500 ppm. For these reasons, condensation is not a technologically feasible control option.

The following remaining potential abatement technologies will be evaluated and analyzed in details since they were recommended by the EPA:

Wet Scrubbers (Gas Absorption)

Absorption is a process where gaseous pollutants are selectively dissolves into a contacting liquid solvent, such as water, alkaline chemicals, or other non-volatile petroleum oils. Applying wet scrubber to control VOC emissions is feasible because ethanol and acetaldehyde are extremely soluble in water. According to EPA document EPA-450/3-91-027 “Assessment of VOC Emissions and Their Control from Baker’s Yeast Manufacturing Facilities”, wet scrubbers can achieve more than 90% control using water as the contacting liquid.

However, the treatment and disposal of the wastewater from the scrubber are not simple. The wastewater must be treated with caustic agents before it can be sent to the sewer system.

Thermal Oxidation

Thermal oxidation is a combustion process that converts organic compounds into carbon dioxide and water. A thermal oxidizer is normally operated at a minimum 1400^{o}F with a nominal residence time of 0.75 seconds to ensure 98% destruction efficiency.

According to EPA document EPA-450/3-91-027 “Assessment of VOC Emissions and Their Control from Baker’s Yeast Manufacturing Facilities”, oxidation is a feasible control method. However, nitrogen oxides (NOx), carbon monoxide (CO), precursor organic compounds and small amounts of particulate mater will be generated as by-products associated with combustion. The oxidizer’s emission factors for CO (0.8 lb/million Btu (MMBtu)) and NOx (0.2 lb/MMBtu) are limited by the District’s Reasonable Control Technology (RACT).

Catalytic Oxidation

Catalytic oxidizers employ a bed of active material (catalyst) that facilitates the overall combustion reaction, enabling the conversation at a faster rate and lower reaction temperature. Catalytic oxidizer is normally operated at a lower temperature (600^{o}F) and can achieve the same destruction efficiency as thermal oxidizers. The catalyst bed needs to be replaced approximately every 5 years due to the poisoning effect some compounds have on the catalyst.

Biofiltration (Biofilter)

Biofilters are compost beds of tree bark, peat, heather or soil, or a mixture of various materials, that have been inoculated with aerobic microorganisms. The VOCs in the gas stream are metabolized by the microorganisms and converted to carbon dioxide and water. Biofilters are suitable for the VOC-ladden, relative high humidity gas stream from yeast manufacturing and the removal efficiency is 90% or better for volatile organics. The critical parameters for a biofiltration system are steady VOC concentration, pH, temperature and moisture. Fluctuation in VOC concentration of the inlet gas may result in an imbalance of alcohol conversion. Decreasing the pH of the bed would kill the microorganisms. Therefore, the combination of a scrubber plus a biofiltration system provides more stability, and may be a better approach to control emissions from a batch process.

An abatement system consisting of a scrubber followed by a biofiltration system was installed at the yeast plant in New Jersey owned by Gist-Brocades. Gist-

Brocades experienced numerous operational problems with the biofiltration system, and it is not clear whether the system was still working after American Yeast acquired the plant.

COST OF CONTROL

NOTE: THESE COST CALCULATIONS ARE PRELIMINARY. THEY NEED TO BE REVISED TO REFLECT CONTROL OPTIONS THAT CONTROL, FOR EXAMPLE, ONLY STOCK AND/OR 1ST GENERATION BATCHES (ASSUMING THE OTHER BATCHES WILL MEET THE REQUIREMENTS USING PROCESS CONTROLS).

THE CONTROL SCENARIOS THAT ARE USED TO JUSTIFY THE FINAL RULE WILL BE DESCRIBED IN DETAIL IN AN APPENDIX. THE OTHER SCENARIOS WILL BE SUMMARIZED IN THE STAFF REPORT, AND THE DETAILED CALCULATIONS WILL BE AVAILABLE AS A SEPARATE DOCUMENT.

Cost Effectiveness in general

The District has several guidelines against which it measures the reasonableness of abatement costs.

The District's Clean Air Plan lists control measures that are under consideration by the District, estimates the "cost effectiveness" (expressed in dollars per ton of pollutant controlled), and ranks the suggested control measures by that effectiveness. Control measures with a cost effectiveness of more than $17,600/ton are generally considered too expensive to pursue. The Board has recently adopted control measures for ozone control with control costs in the $10,000/ton to $12,000/ton range. These costs are *average* costs; costs at individual facilities may be higher or lower. Usually costs are lower, because once faced with an adopted control standard, the operators have an incentive, and are often successful at achieving the goal at a lower cost.

This control measure is unusual in that there is only one affected facility; control costs may be estimated using the actual operating conditions. Because there is no need to consider the variability of cost at individual installations, the BACT cost-effectiveness criterion might be a more appropriate guideline to use.

The District's BACT policy sets the maximum cost per ton controlled for VOC *for a new source* at $17,600 per ton VOC reduction. Controls that cost more than this amount are considered too costly to be economically feasible, and are generally not required.

Table 4

Cost effectiveness of control options

Control option	Cost effectiveness ($/ton)	Tons/year reduced
Scrubber (all stacks)	$35,366	18.3
Scrubber (Stock & 1st generation only)	$28,275	4.68

Scrubber (Stock only)	$11,481	4.32
Biofilter	$8,388[1]	18.3
Biofilter (Stock & 1st generation only)		4.68
Biofilter (Stock only)		4.32
Regenerative Thermal Oxidizer (all stacks)	$40,773	18.3
Catalytic Oxidizer (all stacks)	$38,048	18.3

The costs for the recommended technologies are based on the EPA Concost program, and the following assumptions are used:

Capital costs (System design parameters)

- High humidity vapor stream, approximately 100 %
- Temperature = 85-96^{o}F (30-35^{o}C)
- Total air flow rate = 35,000 CFM (5 fermenters at 7,000 CFM each)
- 87 ppm Ethanol and 22 ppm Acetaldehyde (batch averages)
- 24 ft X 80 ft mounting on the roof top of the production building

Annual costs

- Natural gas cost = $0.45/therm
- Electricity cost = $ 0.10/kW-hr
- Wastewater cost = $0.99/unit; 1 unit = 100scf = 748.05gallons
- Labor rate = $25/hr
- Interest = 10%
- Operating hour = 8736 hr/yr assuming 24 hr/day, 7 day/wk and 52 wk/yr

Wet Scrubber (Gas Absorption)

1. Total annualized costs for wet scrubber (all fermenters, 8736 hrs/yr) = $ 649,671

Uncontrolled VOC emissions are 20.3 ton/yr based on Table 1.

VOC emission reduction = 20.3 ton/yr X 90% = 18.27 ton/yr

The cost effectiveness of the scrubber is as follows:

Cost Effectiveness = $ 649,671/yr / 18.27 ton/yr = $ 35,366 /ton VOC reduced

2. Total annualized costs for wet scrubber (Stock and 1st Generation at 2520 hrs/yr) = $ 132,327

[1] NOTE: does not include cost of structural support needed for roof installation. The cost effectiveness calculation will be revised as soon as the information is provided by Lesaffre Yeast.

Uncontrolled VOC emissions are 4.8 (fermenter #2) + 4.5 X 9% (of 1st Gen from fermenter #5) = 5.2 ton/yr based on Table 1.

VOC emission reduction = 5.2 ton/yr X 90% = 4.68 ton/yr

The cost effectiveness of the scrubber is as follows:

Cost Effectiveness = $ 132,327/yr / 4.68 ton/yr = $ 28,275 /ton VOC reduced

3. Total annualized costs for wet scrubber (Stock at 1000 hrs/yr) = $ 49,600

Uncontrolled VOC emissions are 4.8 ton/yr (fermenter #2) based on Table 1.

VOC emission reduction = 4.8 ton/yr X 90% = 4.32 ton/yr

The cost effectiveness of the scrubber is as follows:

Cost Effectiveness = $ 49,600/yr / 4.32 ton/yr = $ 11,481 /ton VOC reduced

Regenerative Thermal Oxidizer

Total annualized costs for regenerative thermal oxidizer = $ 744,917

Uncontrolled VOC emissions are 20.3 ton/yr based on Table 1.

VOC emission reduction = 20.3 ton/yr X 90% = 18.27 ton/yr

The cost effectiveness of the regenerative thermal oxidizer is as follows:

Cost Effectiveness = $ 744,917/yr / 18.27 ton/yr = $ 40,773 /ton VOC reduced

Catalytic Oxidizer

Total annualized costs for catalytic oxidizer = $ 695,136

Uncontrolled VOC emissions are 20.3 ton/yr based on Table 1.

VOC emission reduction = 20.3 ton/yr X 90% = 18.27 ton/yr

The cost effectiveness of the catalytic oxidizer is as follows:

Cost Effectiveness = $ 695,136/yr / 18.27 ton/yr = $ 38,048 /ton VOC reduced

According to the District's BACT policy, the maximum cost per ton controlled for VOC is $17,600 per ton VOC reduction. Since the calculated cost effectiveness of the catalytic oxidizer is much more than $ 17,600 per ton, the catalytic oxidizer is not considered cost effective.

Biofilter

Total annualized costs for biofilter = $ 151,415

Uncontrolled VOC emissions are 20.3 ton/yr based on Table 1.

VOC emission reduction = 20.3 ton/yr X 90% = 18.27 ton/yr

The cost effectiveness of biofilter is as follows:

Cost Effectiveness = $ 151,415/yr / 18.27 ton/yr = $ 8,388 /ton VOC reduced

Note, EPA currently does not have a cost spread-sheet for biofilters. This cost was taken from the Port of Oakland's ROG Emission Reduction Feasibility Study for Lesaffre Yeast Corporation by Science Applications International Corporation. This cost does not include the specific dollar amounts for structural support to mount the biofilters on the roof. Biological material can weigh up to 70 lbs/ft^3 when wet, so the existing roof structure will not be able to support the weight without structural re-enforcement. Therefore, whether a biofilter is considered cost effective or not will depend on the cost of additional roof re-enforcement.

ADVERSE IMPACTS

Health Impacts

At current emission levels, Lesaffre facility has a maximum lifetime cancer risk of 7.8E-6 (7.8 in a million) and the maximum chronic hazard index is 0.46. These calculated levels of risk are within acceptable levels established by the District in its Risk Management Policy.

The proposed Rule will decrease the public exposure to air contaminants, both locally and regionally. No significant health impacts are expected.

Environmental Impacts

The proposed Regulation 8, Rule 53 will dictate a level of control, but not specify a control option. The proposed regulation could result in environment impacts requiring California Environmental Quality Act (CEQA) analyses in the categories of air quality, water resources, fire hazard and energy use.

The proposed regulation could result in some amounts of wastewater requiring treatment if a wet scrubber is used to reduce VOC emissions. The wastewater treatment could be done onsite with addition of caustic agents before reuse of treated wastewater in scrubber or sending treated wastewater to a public treatment system. The potential impact on water quality will need to be assessed.

The proposed regulation may result in the use of a catalytic or thermal oxidizer at the affected site. Oxidizers burn natural gas. Nitrogen oxide and carbon monoxide emissions would increase as a result of gas combustion. The very slight increase in nitrogen oxide and carbon monoxide emissions would be negligible and insignificant.

Another possible control technology is biofiltration, which can be used for abatement of VOCs from a variety of sources. When biofiters become saturated with VOCs and acetaldehyde, they must be replaced. The spent biofilters are considered a hazardous waste and must be disposed of accordingly. There could be an accidental release during storage, handling or transport of spent biofilters.

Staff will be completing a CEQA initial study to evaluate the environmental impacts. A socioeconomic report will also be completed to determine the economic impact of the measure on Lesaffre Yeast Corporation.

CONCLUSION

The proposed Regulation 8, Rule 53 will reduce the VOC emissions and will help to reduce associated odors from Lesaffre Yeast Corporation. This rule presents an opportunity for a significant emission reduction from nutritional yeast manufacturing. This is feasible in the Bay Area and can be enacted readily. The rule will reduce the odor impacts for residents who live near Lesaffre Yeast Corporation. This rule will also help the District to achieve emission reductions needed to bring the District into attainment with the national ozone standard.

Pursuant to the California Health and Safety Code, Section 40727, new regulations must meet findings of necessity, authority, clarity, consistency, non-duplication, and reference. The proposed regulation is:

> Necessary to reduce VOC and odor emissions, and eliminate public nuisances from yeast fermentation process,
>
> Authorized by California Health and Safety Code, Section 40702,
>
> Clear, in that the new regulation specifically delineates the affected industry, compliance options and administrative requirements for industry subject to this rule,
>
> Consistent with other District rules, and not in conflict with state or federal law,
>
> Non-duplicative of other statutes, rules or regulations, and
>
> The proposed regulation properly references the applicable District rules and test methods and does not reference other existing law.

REFERENCES

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2. Maryland Department of The Environment. 1995. Control of Volatile Organic Compound (VOC) Emissions from Yeast Manufacturing. 27.11.19.17.

3. San Joaquin Valley Unified Air Pollution Control District, Best Available Control Technology (BACT) Guideline 5.6.1 and 1A, August 8, 1998.

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APPENDIX

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